Deactivants for Dust Mite Allergens

Background of the Invention

It has been known for a long time that house dust can trigger allergenic reactions in humans, such as asthma and rhinitis. It was reported, as early as 1928, that it was the dust mites in the dust that were the primary source of the allergenic response but it was only in the 1960's that researchers appreciated its significance.

It is believed that the faeces of two particular house dust mite species, *Dermatophagoides farinae* (known as Der-f) and *Dermatophagoides pteronyssinus* (known as Der-p) trigger the immune responses of the body, thereby giving rise to well known allergenic symptoms.

A review of this is given in Experimental and Applied Acarology, 10 (1991) p. 167-186 in an article entitled "House dust-mite allergen" : A review by L. G. Arlian.

Both the Der-f and Der-p species are found throughout the world. In some areas, Der-f will be the sole Dermatophagoides species. In other areas Der-p will be the sole species. In still other areas, the two species are both present through, generally, one or the other will predominate.

One way to overcome these allergenic response has been to vacuum surfaces, such as carpets, that contain the dust mites and their faeces thoroughly and often, but that is both time consuming (i.e. has to be regularly done if one wants to make an allergenic free environment) and is very dependant on the efficiency of vacuum cleaner and filter bag used e.g. micron filter bag or 2-layer vacuum bags.

An alternative method of creating an allergen-free environment has been to denature the allergen, for example as described in US Patent No. 4,806,526. The only effective method however of which we are aware is to apply tannic acid to the allergen. However, tannic acid can cause staining, and this is a particularly acute problem for light coloured carpets (e.g. white and light beige carpets) and other textile surfaces as tannic acid leaves a deep brown stain.

Therefore, we have been looking for allergenic denaturants which will not stain susceptible surfaces such as carpets and still deactivate the allergen.

We have discovered a number of allergen deactivants which are effective against both the Der-f and the Der-p species. Quite surprisingly, we have discovered that some of these deactivants are specific to the type of dust mite allergen being treated. For example an effective Der-f allergen deactivants will not automatically work effectively as a Der-p allergen deactivant.

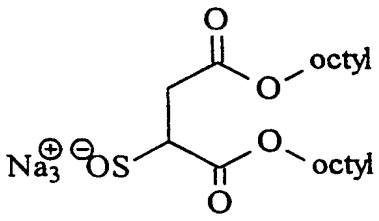
Disclosure of the Invention

According to the invention there is provided a method for deactivating allergens derived from the Der-f and/or Der-p dust mite species, which comprises contacting the allergen with a deactivating effective amount of one or more of deactivants (herein after defined as the deactivant).

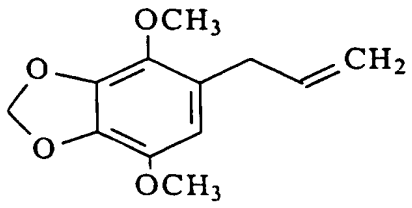
The deactivants effective against one or both of Der-f allergens and Der-p allergens are:

i) cedarwood oil,
ii) hexadecyltrimethylammonium chloride,
iii) aluminium chlorohydrate,
iv) 1-propoxy-propanol-2,
v) polyquaternium-10

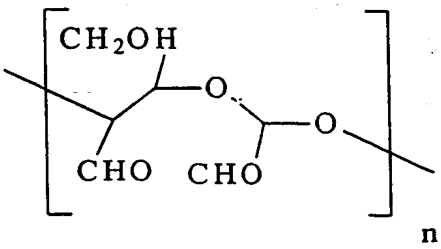
vi) silica gel,
vii) propylene glycol alginate,
viii) ammonium sulphate,
ix) hinokitiol,
x) L-ascorbic acid,
xi) "immobilised tannic acid", (hereinafter defined)
xii) chlorohexidine,
xiii) maleic anhydride,
xiv) hinoki oil,
xv) a composite of AgCl and TiO_2,
xvi) diazolidinyl urea,
xvii) 6-isopropyl-m-cresol,
xviii) a compound of formula I



xix) the compound of formula II



xx) a polymeric dialdehyde containing two or more of a recurring unit of the formula III



where n = 2 to 200,

xxi) urea,
xxii) cyclodextrin,
xxiii) hydrogenated hop oil,
xxiv) polyvinylpyrrolidone,
xxv) N-methylpyrrolidone,
xxvi) the sodium salt of anthraquinone,
xxvii) potassium thioglycolate, and
xxviii) glutaraldehyde

Deactivants (i) through (xx) are effective against both Der-f and Der-p allergens. Deactivants (xxi) through (xxvi) are effective against Der-f allergens only. Deactivants (xxvii) and (xxviii) are effective against Der-p allergens only.

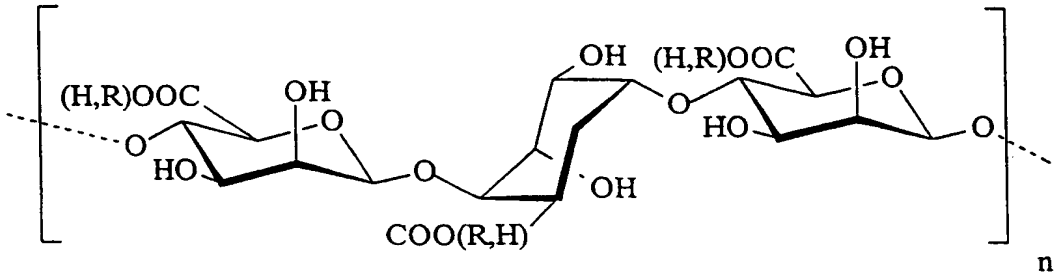
A compound of formula I is commercially available as Aerosol OT.

The compound of formula II is commercially available as parsley camphor.

Hinoki oil is a mixture of thujan-3-one, 2-pinene, 3,5,7,3',4'-pentahydroflavanone and 1,3,3-trimethyl-2-norcamphanone.

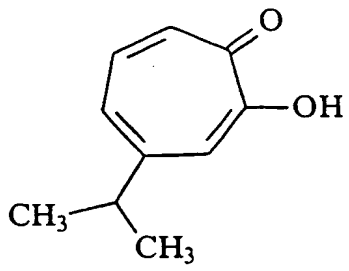
Hydrogenated Hop Oil is the potassium salt of tetrahydroiso humulinic acid (also known as reduced isomerised hop extract).

Propylene glycol alginate is



Chlorohexadine is 1,1'-hexamethylenebis[5-(4-chlorophenyl)]-biguanide.

Hinokitol is β-thujaplicin, a compound of the formula



Germall II is diazolidinylurea.

Thymol is 6-isopropyl-m-cresol.

Cedarwood oil contains α- and β- cedrene (ca 80%), cedrol (3-14%) and cedrenol. Other sesquiterpenes and some monoterpenes are also present.

Polyquaternium-10 is a polymeric quaternary ammonium salt of hydroxyethyl cellulose reacted with a trimethyl ammonium substituted epoxide commercially available as Polymer JR-125.

Silica gel is also known as colloidal silica or silicic acid and is commercially available as Kent.

"Immobilised tannic acid" is tannic acid on polyvinyl pyrrolidone beads. Immobilised Tannic Acid was prepared as follows: 100 mg of tannic acid was dissolved in water; 50 mg of Polyclar 10 (ISP, Guildford Surrey) polyvinyl pyrrolidone beads were added and stirred for one hour; the beads were filtered off the solution and washed with a few mls of iced water until no colour was seen in the washings; they were then dried in the oven at 50°C.

The composite of silver chloride and TiO_2 is made up of 20% wt/wt AgCl on 80% TiO_2 3-5 μm porous beads.

In compositions containing the deactivant, the deactivant is present in an amount of from 0.01% to 7%, preferably from 0.01% to 3%.

In methods for treating rugs and carpets to deactivate allergents, the amount of deactivant present is from about 16gm to about 170gm per 10 square meters, preferably about 32gm per 10 square meters.

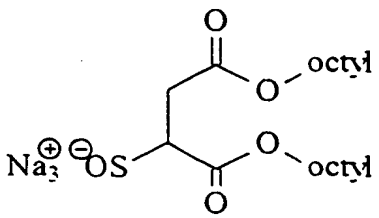
Preferably the deactivant is selected from

xiv) hinoki oil,
xv) a composite of AgCl and TiO_2,
xvi) diazolidinyl urea
xvii) 6-isopropyl-m-cresol,
xii) chlorohexidine,
xiii) maleic anhydride,

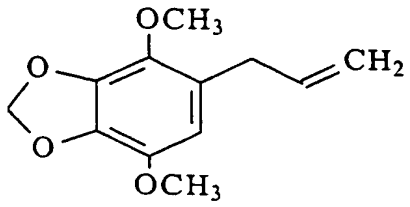
xxvi) the sodium salt of anthraquinone and
xviii) a compound of formula I or II, defined above, and
xix) a compound of formula II, defined above.

Further according to the invention there is provided an aerosol composition containing

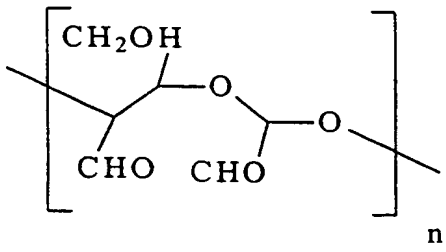
i) cedarwood oil,
ii) hexadecyltrimethylammonium chloride,
iii) aluminium chlorohydrate,
iv) 1-propoxy-propanol-2,
v) polyquaternium-10
vi) silica gel,
vii) propylene glycol alginate,
viii) ammonium sulphate,
ix) hinokitiol,
x) L-ascorbic acid,
xi) "immobilised tannic acid", (hereinafter defined)
xii) chlorohexidine,
xiii) maleic anhydride,
xiv) hinoki oil,
xv) a composite of AgCl and TiO_2,
xvi) diazolidinyl urea,
xvii) 6-isopropyl-m-cresol,
xviii) a compound of formula I



xix) the compound of formula II



xx) a polymeric dialdehyde containing two or more of a recurring unit of the formula III



where n = 2 to 200,

xxi) urea,

xxii) cyclodextrin,

xxiii) hydrogenated hop oil,

xxiv) polyvinylpyrrolidone,

xxv) N-methylpyrrolidone,

xxvi) the sodium salt of anthraquinone,

xxvii) potassium thioglycolate, and

xxviii) glutaraldehyde

b) a propellant, and

c) optionally, a solvent.

Preferably the amount of deactivant present in such a composition is from 0.01% to 7%, more preferably 0.01% to 3%,

Preferably the amount of propellant present in such a composition is from 4% to 50%, more preferably from 4% to 30%,

Preferably the amount of solvent present in such a composition is 0% to 99.95%, more preferably 0% to 90%, and most preferably from 20% to 90%.

Preferably the deactivant in such aerosol composition is selected from

hinoki oil,
a composite of AgCl with TiO_2,
diazolidinyl urea,
6-isopropyl-m-cresol,
chlorohexidine,
maleic anhydride,
the sodium salt of anthraquinone, and
a compound of formula I or II defined above.

Preferably the propellant is selected from those commercially available, for example C_{1-4} alkanes, chlorofluorocarbons and compressed gases such as nitrogen, air and carbon dioxide.

Preferably the solvent is selected from C_{1-6} alcohols (e.g. ethanol) or water.

In addition, the compositions of this invention may also contain one or more of the following:

a fragrance, preferably in an amount of 0% to 5%, more preferably 0% to 2%;

an antimicrobial compound e.g. alkyldimethylbenzyl ammonium saccharinate, preferably in an amount of 0.01% to 1%;

a surfactant, e.g. Dow Corning 193 Surfactant, preferably in an amount of 0.01% to 1%;

a corrosion inhibitor, e.g. sodium nitrite, sodium benzoate, triethanolamine and ammonium hydroxide, preferably in an amount of 0.01% to 10%; and

a miticide, such as benzyl benzoate, pyrethroid pemethrin, d-allethrin and optionally a synergist such as piperonyl butoxide, preferably in an amount of 0.1% to 10%.

It has been found that deactivants of the invention have as effective allergen deactivating properties as tannic acid but without the drawback of staining.

The invention will now be illustrated by the following Examples.

Examples

The test procedure in Examples 1 to 55 is as follows and is known as the ELISA protocol.

The ELISA protocol for Der-f and Der-p has been developed as follows as a measure of denaturing property for denaturants.

ELISA Protocol 1

1. Dust is collected from Hoover™ vacuum cleaner bags and passed through a series of sieves down to 63 microns.

2. Clean petri dishes are labelled with the chemical to be tested (on the base). Three replicates are used for each treatment.

3. Filter paper is used to line each dish and 0.2g of dust is added to each dish onto the filter paper. The lid (or base, as dishes are inverted) is replaced and the dish is shaken to disperse the dust evenly over the filter paper.

4. 2% aqueous solutions of deactivant were used except for the silver chloride composite where 0.05% was used instead. Immobilised tannic acid was used as a 1% dispersion. The hydrogenerated hop end was used at the 2% level (in the form of a 10% solution). Water-insoluble deactivants were emulsified with a sorbitone oleate surfactant (i.e. Tween). Hinokitol was used at 0.5% not 2%.

5. The dust is sprayed with the corresponding treatment, 2 sprays are required for sufficient coverage(1 spray = 1.5 ml).

6. Leave uncovered at room temperature, in well aerated room, until filter paper is dry. This can take up to 4 hours.

7. Empty dust in epindorfs labelled according to treatment.

8. Add 1 ml of 5% Bovine Serum Albumen Phosphate Butter Saline - Tween BSA-PBS-T to each epindorf (5 times the weight of dust) (20ml of BSA-PBS-T =1 g of BSA in 20ml of PBS-T).

9. Leave overnight in a refrigerator.

10. Centrifuge for 5 minutes at 13,000 rpm.

11. Decant the supernatant into a new epindorf labelled according to treatment.

12. Centrifuge again for 5 minutes at 13,000 rpm.

13. Make up dilutions of 1:10 and 1:100 by adding 100 µl of neat solution to 900 µl of 1% BSA-PBS-T (1:10). This is repeated using 100 µl of 1:10 dilution and add to 900 µl of 1% BSA-PBS-T for 1:100 dilution.

ELISA Protocol 2 for Der-f and Der-p: Indoor Biotechnologies

1. Prepare samples and dilutions as in protocol

2. Prepare 500 ml of 50 mM carbonate/bicarbonate buffer by dissolving 0.795g Na_2CO_3 and 1.465g $NaHCO_3$ in 500 ml of distilled water. Check the pH is at 9.6. (This solution is kept in the refrigerator in a conical flask).

3. Monoclonal antibody (kept in the freezer) has to be added to the buffer using the following method, (1 µg per well; 11 ml is needed) applied to the ELISA plate

- 11ml of carbonate/bicarbonate buffer is added to the dispensing tray.

- 11µl of Der-f1 or Der-p1 monoclonal antibody

(Stored in freezer, epindorf in use is in the refrigerator) is added to the buffer. To ensure that all the antibody is removed from the tip, wash out the pipette tip by sucking up and down I the buffer solution, gently stirring to mix thoroughly.

4. Pipette 100 µl of the antibody solution into each well of the microtiter plate, cover with a plate sealer and leave overnight at 4°C.

5. Empty the plate by quickly inverting it over the sink, then dry by banging on a stack of paper towels.

6. Add 200 µl of wash buffer to each well: PBS/0/05% tween (PBS-T).

7. Repeat stages 5 and 6 once more (making a total of 2 washes).

8. Make sure all the wells are dry, then add 100 µl of 1% BSA-PBS-T. Replace the plate sealer and incubate for 1 hour at room temperature*.

9. Repeat steps 5 to 7 (2 washes).

10. *During the hour incubation period, prepare the allergen standards at dilutions between 125 and 1 µg/ml Der f 1 or Der p1:

- Add 25 µl of allergen standard (kept in the refrigerator in polystyrene box) to 475 µl of 1% PBS-BSA-T and mix thoroughly - labelled '125'.

- 250 µl of 1% PBS-BSA-T is added to 7 further epindorfs which are labelled 62.5, 31.25, 15.63, 7.61, 3.9, 1.95 and 0.98.

- 250 µl is taken from the 1st epindorf (labelled 125) and transferred to the next (labelled 62.5). This is mixed thoroughly.

- Using a new pipette tip, 250 µl is removed from epindorf labelled 62.5 and transferred to 31.25, this procedure is continued down to the 0.98 concentration (125, 62.5, 31.25, 15.63, 7.61, 3.9, 1.95, 0.98)

- In total 475 + (250 x 7) = 2.3ml : 0.023g of BSA added to 2.3 ml of PBS-T.

11. Add 100µl aliquots of the allergen sample to the plate along with the standard allergen samples for the reference curve in duplicate. The standards usually go in the first two columns on the left hand side, with the least concentrated on top. Incubate for 1 hour.

12. Follow stages 5 to 6, completing a total of 5 washes.

13. Pour 11 ml of 1% BSA-PBS-T(0.11g of BSA to 11ml of PBS-T) to the dispensing tray. Add 11 µl of the biotinylated monoclonal antibody (refrigerator) and mix thoroughly.

14. Pipette 100 µl into each well and incubate for 1 hour at room temperature.

15. Empty plate and wash as described in stage 12. (5 washes).

16. Add 11 µl of Streptavidin (freezer) to 11 ml of 1%BSA-PBS-T. Pipette 100 µl into each well and incubate for 30 minutes. Reserve any remaining solution in a vial.

17. Empty plate and wash as described in stage 12 (5 washes).

18. Make a solution of OPD, by putting the two tablets (in silver and gold foil) into 20 ml of distilled water (in a glass vial). Shake quite vigorously in the dark until the tablets have dissolved (Wrap the vial up either in tin foil or paper towel).

19. Add a small amount to the remaining solution from stage 16. Wait for a colour change (positive reaction). Add 200 µl to each well and incubate for a minimum of 30 minutes in the dark.

20. Read the plate at 450nm/405nm if filter not available.

Examples 1 to 26

The deactivants, as set out in the following table, were used against Der-f allergens according to the above procedure and the results are as given below. Tannic acid was used as a comparator. What was measured after treatment with deactivant and tannic acid was the amount of allergen remaining active after treatment. The ratio of amount of remaining active allergen after treatment with deactivant and tannic acid is also given.

Table

Example	Deactivant	Amount of Allergen remaining active after deactivant treatment	Amount of Allergen remaining active after tannic acid treatment	Ratio of remaining active allergen after Deactivant/Tannic Acid Treatment	Number
1	Urea	3750	1500	2.500	xxi
2	Polymeric dialdehyde	1325	550	2.409	xx
3	Cedarwood oil	1800	750	2.400	i
4	Cyclodextrin	3850	1700	2.265	xxii
5	hexadecyltrimethylammonium chloride	4075	1800	2.264	ii
6	Aluminium chlorohydrate	1675	750	2.233	iii
7	1-propoxy-propanol-2	3950	1800	2.194	iv
8	Silica Gel (Kent)	2037.5	933.5	2.183	vi
9	polyquaternium-10 (Polymer JR-125)	4335	2000	2.168	v
10	Hydrogenated Hop Oil	1100	550	2.000	xxiii
11	Propylene glycol alginate	3175	1700	1.868	vii
12	Poly vinyl pyrrolidone	2450	1425	1.719	xxiv
13	Ammonium sulphate	2750	1700	1.618	viii

Example	Deactivant	Amount of Allergen remaining active after deactivant treatment	Amount of Allergen remaining active after tannic acid treatment	Ratio of remaining active allergen after Deactivant/Tannic Acid Treatment	Number
14	Hinokitol (0.5%)	3065	2000	1.533	ix
15	N-methyl pyrrolidone	1600	1175	1.362	xxv
16	L-Ascorbic Acid	2000	1500	1.333	x
17	Immobilised Tannic Acid	1550	1175	1.319	xi
18	Aerosol OT	1525	1175	1.298	xviii
19	Chlorohexidine	1412.5	1425	0.991	xii
20	Parsley Camphor	1225	1387.5	0.883	xix
21	Maleic anhydride	1312.5	1500	0.875	xiii
22	Anthraquinone sodium salt	1530	2000	0.765	xxvi
23	Hinoki oil	1025	1387.5	0.739	xiv
24	Composite of AgCl and TiO_2	1025	1425	0.719	xv
25	Germall II	950	1387.5	0.685	xvi
26	Thymol	725	1387.5	0.523	xvii

SUBSTITUTE SHEET (rule 26)

Examples 27 to 47

The deactivants, as set out in the following table, were used against Der-p allergens according to the above procedure and the results are as given below. What was measured were the amount of allergens remaining after treatment with deactivant and the amount of allergens remaining after vacuuming with no deactivant treatment.

Table

Example	Deactivant	Amount of active Allergen remaining after deactivant treatment	Amount of active Allergen remaining after no deactivant treatment but only vaccuming	Deactivant
1	Glutaraldehyde	816	3375	xxviii
2	Polymeric dialdehyde	2792	3375	xx
3	Cedarwood oil	3375	6000	i
4	hexadecyltrimethylammonium chloride	2863	4992	ii
5	Aluminium chlorohydrate	978	4992	iii
6	1-propoxy-propanol-2	1233	4992	iv
7	Silica Gel (Kent)	1540	4992	vi
8	polyquaternium-10 (Polymer JR-125)	5463	6250	v
9	Propylene glycol alginate	3781	6250	vii
10	Ammonium sulphate	2325	6250	viii
11	Potassium thioglycolate	3092	3375	xxvii

Example	Deactivant	Amount of active Allergem remaining after deactivant treatment	Amount of Allergem remaining after no deactivant treatment	Deactivant
12	Hinokitol (0.5%)	2058	3375	ix
13	L-Ascorbic Acid	1438	5642	x
14	Immobilised Tannic Acid	1125	5642	xi
15	Aerosol OT	4494	5642	xviii
16	Chlorohexidine	2281	4450	xii
17	Parsley Camphor	2581	4450	xix
18	Maleic anhydride	783	4450	xiii
19	Hinoki oil	1644	3400	xiv
20	Composite of AgCl and TiO_2	1632	3400	xv
21	Thymol	1500	3400	xvii

Examples 48-55

Further samples were tested as above and compared against tannic acid. The ratio of actives remaining after deactivant treatment and actives remaining after tannic acid treatment are given below:

Example	Deactivant	atio of actives remaining after deactivant treatment over those remaining after tannic acid treatment	Number
48	Germall II	1.5	vi
49	N-methyl pyrrolidone	4.0	xv
50	Hinoki Oil	4.0	iv
51	Silver chloride/TiO_2	3.5	v
52	Thymol	4.0	vii
53	Chlorohexidine	3.0	ii
54	Maleic anhydride	1.0	iii
55	Glutaraldehyde	1.5	xviii

Examples 56-59

The following formulations can be made up as carrier compositions for use in an aerosol for deactivating Der-f and Der-p allergens.

Example 56

Raw Ingredient Description By Weight	Item Classification	%
Anhydrous Ethanol (SD Alcohol 40)	Solvent	79.646
Alkyl dimethyl benzyl ammonium saccharinate	Cationic Surfactant	0.106
Corrosion Inhibitor (I)		0.192
Corrosion Inhibitor (II)		0.192
Corrosion Inhibitor (III)		0.096
Deionized Water	Water/Solvent	15.768
Carbon Dioxide	Propellant	4.000
TOTAL		100.000

Example 57

Raw Ingredient Description by Weight	Item Classification	%
Anhydrous Ethanol (SD Alcohol 40)	Solvent	* 57.000
Fragrance#17	Fragrance	0.0500
Dow Corning 193 Surfactant	Surfactant	0.025
Corrosion Inhibitor (I)		0.100
Corrosion Inhibitor (II)		0.100
Deionized Water	Water/solvent	* 14.725
NP-40/Butane 40	Hydrocarbon propellant	28.000
TOTAL		100.000

* = May replace with 95% Ethanol (SD Alcohol 40) at 61.755% by weight and 9.970% by weight Deionized water

Example 58

Raw Ingredient Description by Weight	Item Classification	%
Anhydrous Ethanol (SD Alcohol 40)	Solvent	79.646
Benzyl Benzoate - an acaricide	Active/ester	4.600
Alkyl dimethyl benzyl ammonium saccharinate	Cationic Surfactant	0.106
Corrosion Inhibitor(I)		0.192
Corrosion Inhibitor (II)		0.192
Corrosion Inhibitor (III)		0.096
Deionized Water	Water/solvent	11.168
Carbon Dioxide	Propellant	4.000
TOTAL		100.000

Example 59

Raw Ingredient Description by weight	Item Classification	%
Anhydrous Ethanol (SD Alcohol 40)	Solvent	*57.000
Benzyl Benzoate	Active/ester	4.600
Fragrance#17	Fragrance	0.0500
Dow Corning 193 Surfactant	Surfactant	0.025
Corrosion Inhibitor (I)		0.100
Corrosion Inhibitor (II)		0.100
Deionized Water	Water/solvent	*10.125
NP-40/Butane 40	Hydrocarbon propellant	28.000
TOTAL		100.000

* = May replace 95% Ethanol (SD Alcohol 40) at 61.755% by weight and 5.370% by weight Deionized water.